We claim:

1. A process for producing a foam comprising at least 70% by weight of carbon by pyrolysis of polymer foams which comprise at least 30% by mass of a polymer material having a nitrogen content of more than 6% by mass and having a porosity of from 35% to 99.5% and an open cell content above 1%, have inorganics selected from the group consisting of zinc chloride, calcium carbonate, ammonium polyphosphate, expanded graphite and metal powders incorporated into the polymer foam and/or applied to the surface and/or are treated during and/or after the pyrolysis with water vapor and/or carbon dioxide at above 400°C.

2. A process as claimed in claim 1, wherein the polymer foams used are or comprise urea-formaldehyde resins.

3. A process as claimed in claim 1, wherein the polymer foams used are or comprise melamine-formaldehyde resins.

4. A process as claimed in claim 1, wherein the polymer foams used are or comprise polymeric isocyanate adducts.

5. A process as claimed in claim 1 or 4, wherein the polymeric isocyanate adducts used contain polyisocyanurate structures which have a ratio A_r of the absorbance of the isocyanurate band in the middle infrared region at about 1410 cm^{-1} recorded using the pressed potassium bromide pellet technique after preparation to the absorbance of the aromatic bands at about 1600 cm^{-1} of greater than 1.5.

6. A process as claimed in any of claims 1 or 4 to 5, wherein the polymeric isocyanate adducts used are prepared by reacting polyisocyanates with themselves, with compounds containing hydrogen-active groups or with further compounds which react with isocyanate in the presence of catalysts, stabilizers, blowing agents and, if desired, further auxiliaries.

7. A process as claimed in any of claims 1 or 4 to 6, wherein hydroxyl-containing polymerization products having a molar mass of greater than 200 g/mol und a functionality of greater than 1 are used as compounds containing hydrogen-active groups.

8. A process as claimed in any of claims 1 or 4 to 7, wherein polyesterols based on aromatic polycarboxylic acids and polyfunctional alcohols are used as compounds containing hydrogen-active groups.

9. A process as claimed in any of claims 1 or 4 to 8, wherein the further compounds which react with isocyanate contain organic acid anhydride structures.

10. A process as claimed in any of claims 1 or 4 to 7, wherein the further compounds which react with isocyanate contain epoxide structures.

11. A process as claimed in any of claims 1 or 4 to 10, wherein at least one compound having a crown ether structure is used as catalyst.

12. A process as claimed in any of claims 1 to 11, wherein as yet uncured phenolic resin components are employed in addition to the polymer foams used.

13. A process as claimed in any of claims 1 to 12, wherein inorganic salts, metal powders or expanded graphite are used as fillers in the preparation of the polymer foams used in an amount of from 0.1% by mass to 60% by mass, based on the total mass of the polymer foams.

14. A process as claimed in any of claims 1 to 23, wherein the polymer foams used are impregnated with solutions or dispersions of inorganic salts, metal powders or expanded graphite in water or organic solvents in such a way that an amount of from 0.1% by mass to 60% by mass of the inorganics remains on the foam after evaporation of the solvent.

15. A process as claimed in any of claims 1 to 14, wherein the inorganic salts used are zinc chloride and/or calcium carbonate and/or ammonium polyphosphate.

16. A process as claimed in any of claims 1 to 15, wherein the pyrolysis of the polymer foams is carried out by heating from room temperature to over 500°C and above 500°C to a temperature of 3000°C.

17. A process as claimed in any of claims 1 to 16, wherein heating is carried out at heating rates of from 0.05 K/min to 10 K/min during the pyrolysis.

18. A process as claimed in any of claims 1 to 17, wherein the pyrolysis of the polymer foams is carried out in an atmosphere of nitrogen and/or noble gases.

19. A process as claimed in any of claims 1 to 18, wherein the pyrolysis of the polymer foams is carried out by heating from room temperature to a temperature in the range from 400°C to 1200°C in nitrogen and/or noble gas and at higher temperatures in a mixture of water vapor with nitrogen and/or noble gas containing from 0.5% by volume to 80% by volume of water vapor.

20. A process as claimed in any of claims 1 to 19, wherein the pyrolysis of the polymer foams is carried out by heating from room temperature to a temperature in the range from 400°C to 1500°C in nitrogen and/or noble gas and at higher temperatures in a mixture of carbon dioxide and nitrogen and/or noble gas containing over 1% by volume of carbon dioxide.

21. A process as claimed in any of claims 1 to 18, wherein the pyrolysis of the polymer foams is carried out by heating from room temperature to a temperature in the range from 400°C to 1500°C in nitrogen and/or noble gas and at higher temperatures in carbon dioxide.

22. A process as claimed in any of claims 1 to 18, wherein the foam comprising at least 70% by weight of carbon is firstly produced by pyrolysis in nitrogen and/or noble gas and is subsequently treated at above 500°C with a mixture of water vapor and nitrogen and/or noble gas containing from 1% by volume to 80% by volume of water vapor.

23. A process as claimed in any of claims 1 to 18, wherein the foam comprising at least 70% by weight of carbon is firstly produced by pyrolysis in nitrogen and/or noble gas and is subsequently treated at above 500°C with a mixture of carbon dioxide and nitrogen and/or noble gas containing over 1% by volume of carbon dioxide.

24. A process as claimed in any of claims 1 to 18, wherein the foam comprising at least 70% by weight of carbon is firstly produced by pyrolysis in nitrogen and/or noble gas and is subsequently treated at above 500°C with carbon dioxide.

25. A process as claimed in any of claims 1 to 24, wherein the pyrolysis of the polymer foams is carried out in the temperature range from room temperature to 1500°C in the presence of oxygen in an amount of from 0.05% by volume to 30% by volume, based on the total amount of gas.

26. A process as claimed in any of claims 1 to 25, wherein the flow rate of the gas streams during the pyrolysis or the after-treatment of the foam comprising at least 70% by weight of carbon is from 0.01 liter per hour to 10 liters per minute and gram of foam.

27. A foam comprising at least 70% by weight of carbon and having a mean cell size above 20 µm, a porosity based on this cell size of from 35% to 99.5% and an open cell content above 90%, an internal surface area above 50 m^2/g, having cell struts whose cross section is a triangle having concave sides and having pores in the cell framework material having dimensions of from 0.2 nm to 50 nm and a volume of from 0.01 cm^3/g to 0.8 cm^3/g, produced according to claim 1.

28. The use of a foam as claimed in claim 27 for electrical and electrochemical applications, as filter and thermal insulation material, as support and storage material and as starting material for further reactions.

29. The use of a foam as claimed in claim 27 or of a pulverulent material obtained from such a foam as claimed in claim 7 as electrode material for supercapacitors and/or in fuel cells.

Foams composed predominantly of carbon and having a high internal surface area and their production

Abstract

The invention relates to a foam comprising at least 70% by weight of carbon and having a mean cell size above 20 µm, a porosity based on this cell size of from 35% to 99.5% and an open cell content above 90%, an internal surface above 50 m^2/g, having cell struts whose cross section is a triangle having concave sides and having pores in the cell framework material having dimensions of from 0.2 nm to 50 nm and a volume of from 0.01 cm^3/g to 0.8 cm^3/g, and also to its use.

It further relates to a process for producing a foam comprising at least 70% by weight of carbon by pyrolysis of polymer foams which comprise at least 30% by mass of a polymer material having a nitrogen content of more than 6% by mass and having a porosity of from 35 to 99.5% and an open cell content above 1%, have inorganics incorporated into the polymer foam and/or applied to the surface and/or are treated during and/or after the pyrolysis with water vapor and/or carbon dioxide and/or oxygen at above 400°C.